

**REMARKS**

Claims 1-2 and 6-7 are pending with claims 3-5 and 8-12 being canceled.

The support for the amendments to claims 1 and 7 are claims 5 and 10 respectively. The applicants assert that no new matter has been added.

**Claims 1, 2, 4, 6 are rejected under 35 U.S.C.112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Particularly, claim 1 recites the limitation "fluorine-contacting" in line 9. There is insufficient antecedent basis for this limitation in the claim.** (Office Action, p. 2)

Claim 1 has been amended thereby overcoming this rejection.

**Rejection of Claims 1, 2, 4, 6-7 and 9 under 35 USC 103 as Being Unpatentable over Sato et al (6,270,948) in view of Kwean et al (6,897,153)**

First, claims 1 and 6 have been amended to specifically recite compounds, "1, 1, 1, 2, 4, 4, 5, 5, 5-nonafluoro-2-pentene, 1, 1, 1, 3, 4, 4, 5, 5, 5-nonafluoro-2-pentene and perfluoro-2-pentene" which are recited in cancelled claim 5 which is not rejected in this amendment. Therefore the claims as now amended are not suggested in Sato and Kwean.

Sato discloses that the substrate is etched with fluorine-containing plasma gas (col. 73, lines 4-8), but, fails to teach the fluorine-containing compounds as recited in the present claims 1 and 7, including perfluoro-2-pentyne.

Kwean discloses a plasma etching process using, as an etching gas, carbon fluoride gas having a double or triple bond, which includes  $C_5F_8$  (col. 4, lines 18-22 and col. 5, lines 48-60). The  $C_5F_8$  as used in Kwean has a double bond (col. 5, lines 41-54), and is expressed by the chemical formula illustrated in Fig. 2B. Thus, the  $C_5F_8$  is clearly perfluorocyclopentene (i.e., octafluorocyclopentene). Kwean is silent on the use of perfluoro-2-pentyne as used in the claimed invention.

The present inventors submit that the carbon fluoride gas of the formula  $C_5F_8$  which is commercially available at present is only perfluorocyclopentene. More specifically perfluorocarbon compounds having unsaturated bonds are generally difficult to prepare on a commercial scale. Among the  $C_5F_8$  compounds only perfluorocyclopentene, which is produced and supplied commercially by the assignee company (Zeon Corporation), has been used as an etching gas from December, 1998 up to now.

As background the methods for synthesizing perfluoro-2-pentyne have been proposed in the following literature, but these methods are not adopted in industry.

- (i) J. Am. Chem. Soc., vol. 76, p611 (1954)
- (ii) J. Am. Chem. Soc.(C), p454 (1969)
- (iii) J. Org. Chem., vol. 30, p3524 (1965) and
- (iv) J. Am. Chem. Soc., vol. 81, p1767 (1961)

The present inventors found a process for producing perfluoro-2-pentyne industrially advantageously, which is originally described in the specification of the present application.

The inventors submit the benefits of perfluoro-2-pentyne as an etching gas over perfluorocyclopentene which is disclosed in Kwean as follows:

(1) The experiments conducted by the inventors gave the results that the selectivity ratio of [etching rate of silicon oxide film]/[etching rate of resist film] as measured when perfluoro-2-pentyne was used as the etching gas was 1.23 times of the selectivity ratio as measured when perfluorocyclopentene was used. The experiments were conducted by the same procedures as described in Example 1 of the present specification. This numerical value "1.23 times" may appear to be small, but, it is of great significance from a practical view point because **finer patterns with a high-precision are eagerly desired for semiconductor apparatuses.**

(2) Perfluorocyclopentene has a boiling point of 27°C and thus is liquid or gas at ordinary temperatures. Therefore, perfluorocyclopentene is not stable and has poor handling characteristics. In contrast, **perfluoro-2-pentyne has a boiling point of 5°C and thus is gas at ordinary temperatures, and therefore is stable and has good handling characteristics.**

It would be unexpected that the selectivity ratio of etching rate of perfluoro-2-pentyne is superior to that of perfluorocyclopentene. **Further, perfluoro-2-pentyne was difficult to prepare as of the filing date of the present application.** Therefore, the subject matters of claims 1, 2, 6 and 7 are believed not to be obvious from the combination of Sato with Kwean.

**Rejection of Claims 5 and 10 under 35 USC 103 as Being Unpatentable over Sato et al (6,270,948) in view of Kwean et al (6,897,153) and Middleton (4,621,126)**

The subject matters of claims 5 and 10 have been incorporated in claims 1 and 7, respectively.

Middleton describes the use of 1, 1, 1, 3, 4, 4, 5, 5, 5-nonafluoro-2-trifluoromethyl-2-pentene (col. 6, example 3). It is submitted, however, that Middleton teaches nothing about the use of this fluorocarbon as an etching gas for dry etching, and further that this fluorocarbon is different from 1, 1, 1, 3, 4, 4, 5, 5, 5-nonafluoro-2-pentene embraced by the present claims 1 and 7 in that 1, 1, 1, 3, 4, 4, 5, 5, 5-nonafluoro-2-trifluoromethyl-2-pentene disclosed in Middleton is a perfluorocarbon, whereas, 1, 1, 1, 3, 4, 4, 5, 5, 5-nonafluoro-2-pentene is **not perfluorocarbon but a fluorocarbon having one hydrogen atom.**

With regard to the benefits of 1, 1, 1, 3, 4, 4, 5, 5, 5-nonafluoro-2-pentene over perfluoropentene or the perfluorocarbon as disclosed in Middleton, the present inventors propose the following theory as an accurate representation: Most perfluorohydrocarbons including perfluoropentene are liable to often release a large amount of fluorine radicals in a plasma. The fluorine radicals undesirably etches the resist with the result of reduction in the selectivity of etching rate of silicon oxide film. In contrast, 1, 1, 1, 3, 4, 4, 5, 5, 5-nonafluoro-2-pentene releases only a minor amount of fluorine radicals because a part of fluorine radicals are scavenged by the hydrogen atom of the nonafluoro-2-pentene, with the result of an increase of fluorocarbon activated species. **The increase of**

**fluorocarbon activated species lead to enhancement in the selectivity ratio of etching rate.**

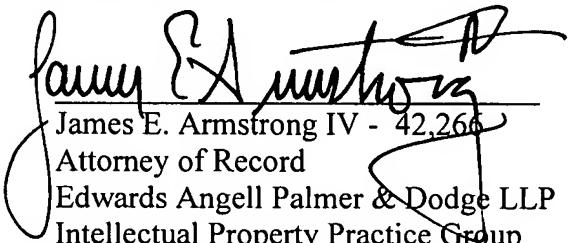
Middleton does not disclose 1, 1, 1, 3, 4, 4, 5, 5, 5-nonafluoro-2-pentene embraced by the present claims 1 and 7, nor teach any fluorocarbon gas for use as an etching gas.

Therefore, the subject matters of claims 1 and 7 are believed not to be obvious from the combination of Sato with Kwean and Middleton.

If, for any reason, it is felt that this application is not now in condition for allowance, the Examiner is requested to contact the Applicant's undersigned agent at the telephone number indicated below to arrange for an interview to expedite the disposition of this case.

The Commissioner is requested to grant any necessary extension of time for this response, if such extension of time is required. The Commission is authorized to charge any fee occasioned by this paper, or credit any overpayment of such fees, to Deposit Account No. 04-1105.

Respectfully submitted,

  
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